ORDA Selection Analysis

When ORDA Systems Engineering was given the task of creating ORDA hardware, the idea was to create a robust, easily upgradeable high performance system to replace existing legacy processing. Systems Engineering and SIGMET looked to replace parts as “deep” into the system as we could without compromising system performance. Several good engineering decisions came from this, including:

Removal of the 4A32
Removal of the “swinging panel” in the receiver
Replaced the analog IF receiver with a digital receiver
Using the burst pulse to “phase lock” the digital receiver
Using one-to-one cabling where possible
Using TCP/IP instead of RS-232 where possible

This paper will give the criteria and reasoning behind the selection of our hardware parts. Alternate parts and reasons for their non-selection will be given also. The selections will be broken down into large logical blocks of similar parts, and an overview of each section will start the section. The basic criteria for parts selection are:

1. NEXRAD Requirements
    a. Environmental, response, troubleshooting, reliability, ergonomics
2. Cost
3. Non-proprietary
    a. Where possible
4. Industry standard
5. RPG Re-use
    a. Reduces logistics, simplifies drawings
6. Installation

- Signal Processing:
    - Analysis by the Government and RSIS revealed the “SIGMET solution” as the best possible compromise to get ORDA fielded quickly and be able to meet “future science” requirements. The SIGMET platform already incorporates many of the enhancements desired, minimizing coding and testing. The highly desired phase coding for range obscuration is being researched on a SIGMET platform. SIGMET’s newest architecture, the RVP8 and RCP8, were chosen for signal processing.
    - The RVP8 and the RCP8 use the same computer platform. This simplifies logistics. SIGMET uses common cards for I/O, once again simplifying logistics. The computer chosen is a dual 3Ghz Pentium 4 (currently we’re using 2.4Ghz processors) with 1GB of high speed RAM. The operating system is Red Hat Linux; a true real-time operating system is not needed for weather radar signal processing.
    - RVP8
        - RSIS analysis showed legacy signal processing is trivial for a modern computer. However, future science desires will consume more and more processing power. SIGMET showed that today’s current general processing CPU’s have matured enough to do weather processing in real time; no longer do we need dedicated DSP chips to do weather signal processing. The RVP8 is based on this premise, and early analysis shows this premise is valid.
    - RCW/RCP8
        - During early development stages, the RCP8 and the RCW (Radar Control Workstation, the “MMI”) were separate computers. Analysis by SIGMET showed neither computer would be stressed at all by the powerful computer chosen for the RCP8. Once seen, it was an easy choice to combine these two tasks into one computer.

- IO Panel
  - Initially, we looked to use the legacy communication with the 4A32. After starting work on explaining the complex multiplexed system, SIGMET suggested removing the 4A32 and going directly to the receiver components themselves. After analysis, this made a lot of sense, and was accomplished. Key to this plan was an interface panel between legacy wiring and SIGMET cabling. This panel made it easy to run cabling to each of the LRU's needing control in the system, and removes the need to create complicated cables. All our cables are straight through pinned one-to-one. Other interface panel designs were considered and rejected at this time, including:
    - Separate panels in the receiver cabinet and in the signal processing cabinet.
    - Putting the interface panel in the receiver cabinet
  - This is an active panel, and provides excellent feedback via LED's on its panel.
  - This panel provides +5V for the Receiver Protector, simplifying wiring and reducing the cables needed between the Receiver and Signal Processor cabinets

- Display
  - Initial plans were to use separate KVM and display system. From the beginning, we wanted to use an LCD display for space reduction, power reduction, and rack mount capability. The first ORDA configurations show a Raritan KVM in place, the same one used by RPG. Research quickly showed the RPG KVM is Sun only. We then found rack mounted KVM/Display systems (Rose Electronics was the first model we found). This model was quite expensive (around $2500), and provided a 4-port KVM. Further research finally found the BSI model we currently have, with an 8-port KVM and a touchpad, for around $1500. Other options we looked at but deemed not as good (although certainly less expensive overall):
    - Buying a conventional CRT
    - Using the RRRAT CRT
  - Any other option would require a separate rack mounted KVM, and considerably more space. Space is not a major concern, but it is certainly more elegant with the LCD display. The reduced space and lighter weight should simplify installation.
  - Testing the BSI KVM revealed severe reliability problems, especially with the keyboard. This problem, along with BSI's unresponsiveness, caused us to seek additional vendors. The market changed dramatically in the last year for these parts. From having trouble finding 2 vendors, we had to select from over 10 vendors. We selected 3 additional parts to test, and selected a KVM from Industrial Computers, a device with an excellent keyboard.
- LAN
  - LAN Switch
    - The legacy system interfaces use mostly RS-232 and X.25 for communications. When we looked at the components we would need to do the ORDA tasks, we saw we needed the ability to connect several components together. The best method was to use a LAN switch to connect these. Our connection needs are modest, and there are no security concerns with our LAN (because of its physical security), so we went with a simple rack mounted unmanaged switch. Concerns now may cause us to change this to a managed switch, mostly to gain SNMP health reports. The managed switch is more expensive (roughly $300 per system) and will require configuration. Also, we may remove the router from the FAA configurations, and then we would need the management capabilities of a managed switch.
    - The unmanaged switch we selected has problems autonegotiating with the RVP8 and RCP8. This has forced us to reevaluate our selection. We have decided to go with a managed switch to obviate any problems with negotiation. This gives us the added bonus of SNMP. We looked at the managed Cisco switch the RPG uses, but it is too costly and provides more functionality than we could ever use at the RDA. It is also a 2U rack mounted unit, and we prefer to use a 1U unit.

        - Our final selection is the Cisco 2950, a 12 port 10/100 layer 3 managed switch. It leverages our knowledge of Cisco devices, and Cisco has been very responsive to our requests.
    - Redundant
        - The legacy system uses RS-232 for interprocessor communication. Our initial intent was to use SIGMET's redundancy for interprocessor work, and that is also RS-232. SIGMET'S redundancy is quite robust, and adds many features not found in the legacy's redundant configuration, including automatic fail over and easy channel selection. We eventually decided to do our own redundant communications, mostly because of the decision to not use SIGMET's IRIS. Our software people wanted to use TCP/IP for this communications link instead of RS-232, and we changed the hardware to support that. This change actually simplifies the design since we already had the LAN to LAN cabling in our diagrams, and now we don't have to put in the RS-232 link (we were going to use existing legacy cabling, thus requiring cable connector adapters).
    - RVP8 to RCP8
        - Originally, we had the LAN connection between the RVP8 and the RCP8 going through the LAN switch. On the recommendation of SIGMET, we've made this a dedicated LAN connection with a crossover cable between the two computers. This has the added benefit of letting us use a gigabit cable to connect these two, giving us higher throughput and less latency.
- Communications
    - Communications with the outside world consist of the link with the RPG (X.25, typically run over a T-1 line) and the ability to dial in with the RRRAT. We knew starting out that X.25 was going to change to TCP/IP, so our hardware had to support that.
    - Router/CSU
        - Using CISCO equipment for our RPG link was a simple decision. RPG uses CISCO, and it is highly reliable and an industry standard. Since our router is only used for RPG communications, we do not need a big model. The 2620 fits our needs perfectly.
        - The initial plan was to use the WIC1 CSU card and keep the legacy CSU. After meeting with CISCO engineers and discussing the WIC1 capabilities, we determined we did not need the legacy CSU's.
        - We are currently looking at removing the router/CSU from the FAA configuration due to its close proximity to the RPG (possibly the DOD configurations as well). If we do this, we will definitely go to a managed switch for the LAN.
            - This idea proved to be too expensive for support, so all sites have a router/CSU.
    - Remote Access
        - Serial Port Switch
            - Currently, technicians dial in to the system with the RRRAT for remote maintenance. This functionality has proved invaluable to the field, and is in the SS requirements. Our solution was to use a serial port switch with an internal modem. The serial port switch is password controlled, inexpensive, and easy to use.
            - Firewall
                - Even though the serial port switch is cheaper and easier to use, it doesn't provide some things required by today's Government security requirements. There's no login audit or identification. Therefore, a firewall machine is required at the interface for remote maintenance access. We are still researching the right machine to use, and we currently see 2 options:

                - Use a rack mounted PC running Linux. We don't need a powerful PC, and desire a 1U unit. This provides us the greatest flexibility
                - Use a console server. These are generally using Linux in a small form closed system. They are very controlled, and less expensive than the rack mounted PC.
        - Remote Access Server (RAS)
            - We chose a RAS from Cyclades for this function. It provides all the security we need, and is reasonably priced.
- Receiver
    - The legacy analog IF receiver portion has been problematic, especially as the systems age. Current digital receivers are inexpensive, more reliable, and provide better performance. One of the main benefits of going with the SIGMET solution was being able to use their proven digital receiver.
    - We had to look at our current receiver, and see where to split the signal, and what parts to keep and eliminate. We aimed to keep the minimum parts needed for accurate system operation and troubleshooting capability. The entire swinging door assembly in the receiver is eliminated in the design. This means there are no more moving cables in ORDA, a definite advantage for system reliability.
    - When we installed the KREX engineering model with the RXNET7, we decided with SIGMET to use our existing klystron burst as an input to the IFD to phase lock our system. This provides exceptional phase locking to improve future algorithms using phase techniques like the SZ Phase Coding. Since the klystron burst is at RF frequency, we needed to mix it down to IF to input into the IFD. This is done in the Engineering Model with a Mixer and a Splitter. Appropriate RF and IF attenuations were added to reach acceptable input power ranges for the IFD. RF cabling is standard semi-rigid SMA cable for low loss and high reliability connections.
        - This burst pulse has caused considerable problems. The level is ok, but the IFD cannot digitize it cleanly. We need a higher power level, but we are already well into compression on the mixer.
    - At Hardware CDR it was brought to our attention that the splitter reduced the STALO signal below recommended levels for the legacy 4A5 Mixer/Preamplifier. We researched several solutions and talked to the 4A5 manufacturer. Bill Urell was asked to study the effect of the splitter on the receive signal, concluding that the splitter had a negligible effect on noise and dynamic range. Based on a suggestion from SIGMET, we decided to use a 6db directional coupler instead of a power splitter. This gives us a lower STALO path loss. See our white paper on this analysis.
- Cabling
    - The legacy system uses many special cables for routing signals. These cables are expensive and difficult to maintain. Our desire was to use commercially available straight through one-to-one cables for all signaling. All the signals in the system are RS 422, and our cabinets are shielded. RS 422 minimizes interference problems, as does the short length of our cables. Also, in the signal processor cabinet, many ribbon cables were used. These are notoriously poor for signal interference, so we will not use any external ribbon cables.
    - Final cable lengths are still to be determined. We estimated needed cable lengths based on knowledge of component locations.
    - Cables will be routed to allow easy access for maintenance, and to eliminate cross talk as much as possible. This will be done primarily by routing signal and power cables separately (at least 2 inches separation desired), and properly dressing cables in the cabinet. In the receiver cabinet, there are several cables being moved, and they will be properly secured.
- Power Management
    - Power management was the "Johny-come-lately" part of the ORDA, the last hardware to be worked on. We knew starting out we were going to duplicate the power management

system of the RPG as much as possible, so we knew we already had a framework to start with. We started by looking at all the configurations, single and dual thread, and figuring out logical equivalents to the legacy states. It was especially difficult to determine an equivalent state to the CDS prompt (the Halt state in legacy RDA). We also had to work on rewiring the NWS redundant capability to control the critical contactor. All this was done using the same components as the RPG.

- APC power manager
    - An easy choice, the APC power manager is an excellent component, and one we would have chosen even without RPG influence
    - The Power Manager the RPG uses has gone out of production, so we will use its replacement
- Baytech
    - Initially we did not plan on using the Baytech on FAA RDA's. The plan was to only have the APC power manager. However, in TIM's (Technical Interchange Meetings) with the FAA, they expressed the desire to use what they already knew, so we added the Baytech power manager to the FAA sites. We only need one per channel.
    - The Baytech power manager the RPG uses has changed, we will be using the updated model
    - We are now planning to eliminate the Baytech in the FAA configuration. The FAA's operational concerns are different than we believed, and we only need to show them its applicability.
- APC UPS
    - Initially we planned on using the APC UPS on the FAA sites only. This is because the FAA TPS is a rotary UPS and can only sustain system power for approximately 30 seconds. This is not enough time for the signal processors to gracefully shut down. We do not have enough data on the ability of the SIGMET RVP8 and RCP8 to recover from a sudden power failure.
    - During TIM's with ROC, they expressed concern over the times in other systems when the TPS is in Bypass, enough concern that eventually we agreed to add the APC UPS to all configurations.
    - This UPS also improves our ability to meet the requirements to continue VCPs with short outages.
    - The UPS the RPG uses has gone out of production, so we will use its replacement
- Powerware UPS
    - The Powerware UPS will run the critical load for approximately 30 minutes. Initially we planned to use the UPS signal "Shutdown Imminent", giving us approximately 2 minutes of power remaining. However, we discovered that due to problems with transfer switches at some sites, "Shutdown Imminent" had been reprogrammed to Bypass immediately. The only other recourse we could find involved a Windows only product, clearly unacceptable for ORDA.
    - After putting the APC UPS in all configurations, we found an acceptable solution for using SNMP with the Powerware UPS, available on Linux. We do not have the time to pursue this approach; therefore we will be deploying the APC UPS in every system.